STATE OF VERMONT
PUBLIC SERVICE BOARD

Docket No. 6860

Petitions of Vermont Electric Power Company, Inc. ("VELCO") and Green Mountain Power Corporation ("GMP") for a Certificate of Public Good authorizing VELCO to construct the so-called Northwest Vermont Reliability Project, said project to include: (1) upgrades at 12 existing VELCO and GMP substations located in Charlotte, Essex, Hartford, New Haven, North Ferrisburg, Poultney, Shelburne, South Burlington, Vergennes, West Rutland, Williamstown, and Williston, Vermont; (2) the construction of a new 345 kV transmission line from West Rutland to New Haven; (3) the construction of a 115 kV transmission line to replace a 34.5 kV and 46 kV transmission line from New Haven to South Burlington; and (4) the reconductoring of a 115 kV transmission line from Williamstown, to Barre, Vermont

PREFILED DESIGN DETAIL TESTIMONY OF GEORGE E. SMITH ON BEHALF OF THE VERMONT DEPARTMENT OF PUBLIC SERVICE

October 14, 2004

Summary: Mr. Smith provides recommendations on VELCO's proposal for the Granite substation, discusses strategies for reducing the height of 115 kV structures, recommends the acquisition of a spare reactor for the New Haven substation, comments on VELCO's proposals for substation noise mitigation, and comments on VELCO's proposal for the Ferry Road crossing in Charlotte.

Prefiled Design Detail Testimony
of
George E. Smith

Identification of Witness and Qualifications

Q. Please state your name and position.

A. My name is George E. Smith. I am a professional engineer and consultant to the Vermont Department of Public Service (Department).

Q. Are you the same George E. Smith that previously submitted testimony in this proceeding?

A. Yes, I am.

Summary

Q. What is the purpose of your testimony?

A. In this testimony, I provide recommendations on VELCO's proposal for the Granite substation, discuss strategies for reducing the height of 115 kV structures, recommend the acquisition of a spare reactor for the New Haven substation, comment on VELCO's proposals for substation noise mitigation, and comment on VELCO's proposal for the Ferry Road crossing in Charlotte.

Granite Substation

Q. In their Design Detail testimony, VELCO witnesses Dunn and Harr indicate that, at this time, VELCO considers the installation of synchronous condensers at the Granite substation to be the preferred technology for providing needed dynamic reactive power to the system. Do you believe that careful attention should be given to the specification and selection of the dynamic VAR device at Granite?

A. Yes. A reliable source of 150 MVARs (+/- 75 MVARs) of dynamic VAR support is required at Granite to maintain system reliability.[1] This device also impacts system power quality and has the potential for significant power losses. As such, careful attention to the device's specification and selection is warranted.[2]

Q. Does VELCO's indication that synchronous condensers are the preferred technology give you cause for concern?

A. Yes, for two reasons. First, I am not aware of any permanent synchronous condenser installations at transmission stations 115 kV and above in the northeast. This would be the first such installation in New England, and any available operational experience that could be obtained from other regions should be carefully considered. Second, while I recognize that this technology offers some potential advantages over solid state electronic (FACTS) technologies, it is not clear that it offers the least-cost solution with regard to life-cycle costs.

Q. How do you propose that VELCO proceed with selecting the appropriate, least-cost dynamic VAR technology for Granite?

A. First, I suggest that VELCO perform a detailed analysis to determine the suitability of synchronous condensers for this transmission application -- specifically to determine if there are any "fatal flaws" regarding technical performance. Second, I suggest that VELCO develop a functional specification for the various applicable technologies and request detailed quotes for a specified modular configuration. The applicable technologies would include synchronous condensers (assuming no fatal flaws were found) and FACTS devices including static var compensators (SVCs) and static compensators (STATCOMs). The specifications would

---

[1]This installation of 150 MVAR would be the first stage of dynamic VAR support planned for Granite.

[2]This device would become even more critical if, in the future, the Highgate source were to be lost entirely, for example, due to the elimination of contract flows from Hydro Quebec.

require, at a minimum, dynamic response characteristics, guaranteed losses (under likely operational profiles), installed cost, the cost of spare parts and/or modules, footprint requirements, guaranteed maximum noise levels, operational and maintenance requirements, the manufacturer's experience with transmission applications, predicted response to faults (power quality), predicted interaction with nearby FACTS and high-voltage direct current (HVDC) installations,[3] conditions under which gate blocks or machine trips are likely to occur, and the vendor's capability to perform system simulations.

Q. Would special studies be required?

A. Yes. Studies would be required: 1) to evaluate the impact (either positive or negative) of a device's dynamic response on nearby customers; and 2) to evaluate the interaction of the device on nearby rotating machines, FACTS devices and HVDC installations.

Q. Who would perform these studies, and when could they be undertaken?

A. Several approaches are possible. One approach would be for VELCO (or its consultant) to perform preliminary studies to assist in developing the specification. Then the vendor, if it has the capability, could perform additional studies during the design process, with oversight by VELCO. If the vendor does not have the capability, then it would be up to VELCO to perform the studies. In any event, the cost of required studies would be a consideration in the technology and vendor selection process.

Q. Do you have any comments on the architecture proposed by VELCO for the proposed installation at Granite?

A. Yes. As indicated in VELCO Exhibit Dunn/Harr DD-20, VELCO has divided the installation into two 75 MVAR sections, each section connected to separate ring bus positions

[3]These would include the STATCOM at Essex, the Highgate converter, and the Phase I HVDC terminal at Comerford, New Hampshire

through separate step-up transformers. Each 75 MVAR section is comprised of two modules, presumably 37.5 MVAR each. This architecture maintains the availability of 75 MVARs in the event of a transformer failure. With a spare transformer on site, full capability could be restored within a day or so. Further, this architecture maintains the availability of 112.5 MVAR (75 MVAR + 37.5 MVAR) in the event of the failure of a single module. In general, this is an appropriate architecture for this application. However, given the importance of this installation to system reliability, consideration should be given to the use of three 25 MVAR modules per section, thereby ensuring that 125 MVARs (75 MVAR + 25 MVAR + 25 MVAR) is available upon failure of any one module. Finally, regardless of the number of modules ultimately employed, consideration should be given to the procurement of a spare, on-site module to ensure rapid recovery to the full 150 MVAR capability upon failure of any single module.

115 kV Line Design

Q. In your prefiled direct testimony in this proceeding dated December 17, 2003, at pages 23 through 25, you recommend a number of strategies for minimizing the height of the 115 kV structures proposed for the New Haven to Queen City corridor. After reviewing VELCO's design detail for selected sections of this line, do you believe that VELCO has taken all available measures to minimize the height of the 115 kV structures in areas where structure height is of particular aesthetic concern?

A. No. While VELCO does propose to use shorter spans to achieve pole height reductions in aesthetically sensitive areas, I believe that more could be done without imposing a significant adverse impact on reliability. Specifically, in areas where shorter spans are used, I believe that an additional 6 ft. of pole could be eliminated above the brace attachment of the top insulator. VELCO's proposed design extends the pole approximately 6½ ft. above this attachment. Where longer span lengths are used, this distance allows clearance for wind induced galloping and conductor motion due to ice release. This distance also allows ample shielding for lightning protection. Reducing the height above the top attachment by 6 ft. would

change the lightning shield angle from approximately 30 degrees to approximately 45 degrees. While a 45 degree shield angle offers somewhat less lightning protection than a 30 degree shield angle, 45 degrees is the level employed on the H-frame construction presently used on most of the VELCO system. Given that the VELCO system experiences lightning outages on the order of one per mile per 100 years, it doesn't seem that the increased shield angle, for a few spans in selected areas, would have a significant adverse impact on reliability.

Q. Are further measures available that could be taken to reduce 115 kV structure heights?

A. Yes. Where shorter spans are employed, there is less concern with conductor motion due to wind induced galloping and ice release. In these situations, the vertical distance between the conductors on the same side of the pole can be reduced from 12 ft. to 8 ft. thereby providing an additional pole height reduction of 4 ft. The combined effect of these two measures result in a total structure height reduction of 10 ft.

345 kV Shunt Reactor

Q. Regarding the New Haven substation design detail, do you believe that VELCO has given adequate consideration to acquiring a spare 345 kV reactor?

A. No. The proposed shunt reactor at New Haven ensures an appropriate voltage profile following contingencies.[4] Without a shunt reactor in place, the loss of the West Rutland to New Haven 345 kV line, under high load conditions, could result in unacceptable voltage levels, possibly leading to voltage collapse. This is particularly true if the Highgate converter is out of service. Because the proposed shunt reactor is important to the reliable operation of the system, and replacement or repair of this device could take up to six months, I believe that procurement of an on-site spare is necessary.

[4]The inductive reactance of the reactor compensates for the line charging capacitance, and associated voltage rise, of the 345 kV line from West Rutland to New Haven.

Substation Noise Mitigation

Q. Do you have any comments on VELCO's proposals for mitigating noise from substations?

A. Yes. VELCO's proposals for mitigating noise at substations appear to be reasonable. Similar measures should be taken, as necessary, at the other NRP substation expansions. I note, however, that VELCO's proposals are based on noise level projections. Therefore, once construction is completed and the substations are in operation, it would be appropriate for VELCO to verify the expected sound levels and to perform further mitigation as may be necessary.

Charlotte, Ferry Road Crossing

Q. Have you reviewed VELCO's design detail proposal for the 115 kV line in the vicinity of Ferry Road and the Waldorf School in Charlotte?

A. Yes.

Q. What comments do you have on VELCO's proposal in this area?

A. From an engineering perspective, VELCO's proposal is viable. However, the amount of tree removal that would be required on the east side of the railroad tracks, even if this amount was kept to an absolute minimum, would result in the elimination of substantial portions of the screening that presently exists between the nearby residential neighborhood and the proposed corridor. The significance of this required tree removal is addressed in the Design Detail testimony of Department witness David Raphael.

Q. Does this conclude your prefiled design detail testimony?

A. Yes.